Ex/EE/T/422B/2019

BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING EXAMINATION, 2019

(4th Year, 2nd Semester)

HIGH VOLTAGE TECHNIQUE - II

Time : Three hours Full Marks : 100

(50 marks for each Part)

Use a separate Answer-Script for each Part

PART - I

Answer any three questions. Two marks for neat and well organized answers.

1. (a) Explain with the help of diagrams how ferro-resonance can damage equipment causing excessive current and voltage when a 3-ph transformer on no-load is connected to a 3-phase source. Explain why a connection through cables is more dangerous in this regard 08

   (b) Derive the single phase equivalent circuit for the scheme when one of the circuit-breaker poles does not close simultaneously with the other two. 08

2. (a) Explain why modal transformation is necessary while calculating the transient response of a three phase power system, and describe the mathematical basis of the transformation matrices. 08

   (b) Derive the [Y] matrix for computing the transient response of a single stage impulse generator circuit with the help of EMTP. 08

3. (a) Explain why during the surge test of a h.v. winding, all the secondary LV windings are kept short-circuited and state how the magnetic flux lines are distributed within and around the windings, as a result of this. 06

   (b) Through a detailed circuit analysis, comment on the important condition for a safe and economical design of a transformer vis-a-vis the voltage distribution along the transformer winding. 10

4. Write short notes on any two. (a) Location and selection of Surge arrestors in a substation (b) Relation between the impulse withstand voltage and the 50% Flashover voltage (c) Representation of a long transmission line in EMTP. 08+08

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PART-II

Answer ***any three*** questions

Two marks are reserved for neatness and well organized answer script

1. a) An impulse current generator consists of 10 impulse capacitors, each of 0.125μF. The circuit inductance is 60μH and the total circuit is critically damped. The charging voltage is 200kV. This impulse generator is used to test surge arresters. Assume that a test arrester maintains a constant voltage of 25kVp across it. Draw a schematic and calculate the following:
(a) The value of series resistance required.
(b) Peak value of current through the arrester under test
(c) Time to peak.
(d) Time to tail. 10

b) In high voltage half wave rectifier circuit, the average d.c. voltage is 70% of the peak a.c. input voltage. If ripple is 15%, calculate the ratio of $\frac{X_C}{R}$, where the symbols have usual meanings. 6

2. a) It is required to measure the output of a 100kV testing transformer with HV winding impedance of 10 kΩ with a compensated RC divider. The HV arm of the divider has 15 numbers of 100 kΩ resistors with a 20 pF capacitor to ground from each of the junction points. The LV arm resistance is 50 Ω. Determine the capacitance needed in the LV arm for correct compensation. 8

b) Explain the terms (i) Insulation Level, (ii) Statistical Impulse Withstand Voltage, (iii) Effectively Earthed System and (iv) Factor of Earthing, with respect to insulation coordination. 8

3. a) Write a brief note on Generating Voltmeter. 10

b) A generating voltmeter with a four pole synchronous motor drive has to be designed so that it can have a range of 20-200kVd.c. If the indicating meter reads a minimum current of 2μA, what should be the capacitance of the generating voltmeter? Also give the maximum range of the indicating instrument. 6

4. a) What is Klydonograph? With the help of suitable diagrams, explain its principle of operation. What is the significance of Lichtenberg figures in lightning impulse voltage measurement? 8

   b) A transformer has an impulse insulation level of 1050kV and is to be operated with an insulation margin of 15% under lightning impulse conditions. A transformer has a surge impedance of 1600Ω and is connected to a transmission line having a surge impedance of 400Ω. A short length of overhead earth wire is to be used for shielding the line near the transformer from direct strikes. Beyond the shielded length, direct strokes on the phase conductor can give rise to voltage waves of the form $1000e^{-0.05t}$kV (t in μs).
   If the corona distortion in the line is represented by the expression

   $$\frac{\Delta t}{x} = \frac{1}{B}\left[1 - \frac{e_0}{e}\right] \text{ μs/m}$$

   Where x is the length of wire in m, B = 110m/μs and e_0 = 200kV, determine the minimum length of shielding wire necessary in order that the transformer insulation will not fail due to lightning surges. 8

5. a) Discuss the principle of operation of a high voltage Schering Bridge showing the evaluation of unknown capacitance and dielectric dissipation factor (tanδ). 10

   b) In testing a capacitor with a Schering bridge, null was obtained when R_4 = 100 ohms, R_3 = 1400 ohms and C_3 = 5nF. Calculate the value of capacitor and its dissipation factor. 6
   Given, standard capacitor = 1nF.